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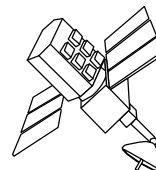
The ARM Unmanned Aerospace Vehicle Program

The ARM Program's focus is on climate research, specifically research related to solar radiation and its interaction with clouds. The SGP CART site contains highly sophisticated surface instrumentation, but even these instruments cannot gather some crucial climate data from high in our atmosphere.

The lowest layer of our atmosphere, known as the "troposphere," is where our weather events take place. The troposphere contains virtually all of the water vapor, clouds, and precipitation in Earth's atmosphere. In the troposphere, air temperature and pressure decrease as height increases up to a point of constant temperature. This level, referred to as the "tropopause," is usually found

at 45,000-65,000 feet above the surface. The tropopause is perceived as the natural cap on the weather environment. Information about this region of the atmosphere is vital to climate researchers.

Although some information about the top of the troposphere and the tropopause can be gleaned from satellite data, the information must be inferred *indirectly*. Satellites in orbits well above the tropopause can measure only reflected or re-radiated signals. In contrast, weather events can be measured *directly* near the tropopause by special unmanned aircraft flying at altitudes of 45,000-65,000 feet for extended periods of time.



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The Department of Energy and the Department of Defense joined together to use a high-tech, high-altitude, long-endurance class of unmanned aircraft known as the unmanned aerospace vehicle (UAV). A UAV (Figure 1) is a



Figure 1. The Altus-II unmanned aerospace vehicle (ARM photo).

small, lightweight airplane that is controlled remotely from the ground. A pilot (Figure 2) sits in a ground-based cockpit and flies the aircraft as if he were actually on board. The UAV can also fly completely on its own through the use of preprogrammed computer flight routines.

The ARM UAV is fitted with payload instruments developed to make highly accurate measurements of atmospheric flux, radiance, and clouds. Data from the instrument payload are radioed to the ground in real time. A great deal of research and development was needed to design lightweight, precision instrumentation that would fit into the small space of a UAV.

One of the ARM UAVs used over the SGP CART site is the Altus-II (Figure 3). This UAV is 24 feet long, has a 55-foot wingspan, and weighs 2,000 pounds fully loaded, including

the instrument payload weight of 330 pounds. The UAV's four-cylinder, four-cycle, liquid- and air-cooled engine provides enough power to fly to 45,000 feet. With a turbocharger installed, the Altus-II can reach altitudes of 65,000 feet. During flights over the CART site, a UAV carried radiometric instruments on a single flight that lasted over 26 hours, proving its value in gathering data over a long period of time.

Using a UAV is beneficial to climate research in many ways. The UAV puts the instrumentation within the environment being studied and gives scientists *direct* measurements, in contrast to *indirect* measurements from satellites orbiting high above Earth. The data collected by UAVs can be used to verify and calibrate measurements and calculated values from satellites, therefore making satellite data more useful and valuable to researchers.



Figure 2. Altus-II control trailer cockpit (ARM photo).

By using a UAV in conjunction with a standard research aircraft, scientists can also make more accurate

measurements of clouds and the way they block and absorb sunlight. The UAV can be flown above the cloud tops, while a research aircraft flies below the base of the clouds directly under the position of the UAV. The UAV can be computer controlled to track directly above the flight path of the manned airplane at all times. This critical positioning allows researchers to make simultaneous measurements at two heights above a single point on the surface, providing details about the effects on solar radiation as it passes through a cloud. This information is extremely important to weather models, which at present cannot account for all of the sun's energy as it penetrates clouds. Understanding clouds and their role in climate is the main goal of the ARM Program.



Figure 3. The Altus-II UAV in flight (ARM photo).

More information about the ARM UAV Program can be obtained from the following web site:
<http://www.arm.gov/uav/>